PROCESS ANDAPPARATUS FOR MAKING A BREATHABLE, ELASTIC POLYOLEFIN FILM

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]This invention relates to a process for preparing a breathable elastic polyolefin film, a plant for implementing such process and the use of a mixture of polyolefins and thermoplastic elastomers for making a breathable elastic film.

Prior Art

[0002]Breathable polyolefin films are used in various technical fields, particularly for making products designed to be impervious to liquids while allowing air and vapor to pass therethrough.

[0003]From patent EP-B1-1 226 013, in the name of the applicant hereof, to which reference is made for a better understanding of the prior art, a process is known for making breathable polyolefin films by transversely and/or longitudinally stretching a polyolefin film, admixed with $CaCO_3$ fillers or equivalent materials.

[0004]According to the teaching of patent EP-B1-1 226 013, the polyolefin film to be stretched is obtained from a process which includes the steps of: producing a tube by blow extrusion, squeezing the tube to obtain two superimposed layers, heating the two superimposed layers to the softening point, pressing the two layers together to strongly join them and cooling the film thus obtained.

[0005]The film obtained by this process has the advantage of allowing higher film stretching rates and ratios, without increasing the risk of generating microholes, which might affect the liquid-imperviousness properties of the film.

[0006] However, the breathable polyolefin films that result from the process of patent EP-B1-1 226 013 have drawbacks. Particularly, the film may not easily conform to the surface to be covered, without risking the rupture thereof, while providing an adequate liquid-tightness.

SUMMARY OF THE INVENTION

[0007]The object of this invention is to provide a solution to prior art problems and particularly to the above mentioned problem.

[0008]The present invention fulfills the above object by providing a process including the steps of: blow extruding a tubular element from a mixture of polyolefin, styrenic thermoplastic elastomers and filler to form a tube; squeezing the tube element to obtain a flat film; heating the flat film to its softening point; pressing the flat film; cooling the flat film to a temperature of 8 to 30°C; and stretching the film in the transverse and/or longitudinal directions to produce a breathable elastic film. Optionally, the process further includes the steps of applying a separating material to the breathable elastic film; and

winding the film with the applied separating material into a roll.

[0009]Preferably the mixture subjected to blow molding comprises 30% to 70% by weight fillers, 10% to 40% by weight styrenic thermoplastic elastomers and 10% to 50% by weight polyolefin.

[0010]The separating material may have a continuous structure or discontinuous structure and may be a paper or nonwoven fabric film. The paper or nonwoven fabric film may be coupled to the breathable elastic film with or without an adhesive. Alternatively, the separating material may be a powder.

[0011]The present invention also provides an apparatus for producing a breathable elastomeric polyolefin film, including, arranged in series, a blow extruder for extruding a tubular film, a calender for squeezing the extruded tubular film exiting the blow molding extruder; means for heating the squeezed extruded tubular film to its softening point; a calender for pressing the film heated to its softening point; means for cooling the compressed film to a temperature of 8 to 30°C; means for stretching the film in the transverse and/or longitudinal directions; and cooling means for cooling the stretched film for stretch stabilization.

[0012]The apparatus of the invention may further include means for coupling the extruded film to a separating material; and a reeling machine for winding the film coupled to said separating material into a roll.

[0013]The present invention also provides a breathable elastic film formed of a mixture of polyolefin, styrenic thermoplastic elastomer and filler. Preferably, the amount of styrenic thermoplastic elastomer is 10% to 40% by weight, the amount of filler is 30% to 70% by weight and the amount of olefins is 10% to 50% by weight.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014]The process and apparatus of the invention will appear more clearly from the following description of an embodiment with reference to the drawing which schematically shows a production plant (apparatus) according to the invention.

[0015]The process uses a mixture of polyethylene, preferably LDPE or LLDPE,styrenic thermoplastic elastomer and filler, usually $CaCO_3$-based, which make the film porous by stretching thereof.

[0016]The polyethylene- and/or polypropylene-based polyolefin may be used, which may be obtained by conventional catalysis methods (Ziegler, Ziegler-Natta, Phillips) or metallocene catalysis, particularly polyethylene copolymers having α-olefins with 4 to 10 carbon atoms (1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 4-methyl-1-pentene, etc.).

[0017]The amount of added filler also depends on the desired breathability, typically the filler is 30% to 70% by weight of the mixture. More preferably, the filler is 40% to 50% by weight of the mixture.

[0018]Other types of organic or inorganic fillers may be used instead of $CaCO_3$. Particularly, the following fillers may be used: clay, kaolin, zeolites, Zn, Al, Ca, $CaSO_4$, $BaSO_4$, MgO, $Mg(OH)_2$, TiO_2. Preferably, the fillers have an average particle size of 0.5 to 2 μm and are processed to make their surfaces hydrophobic.

[0019]The fillers may be further coated with fatty acids, e.g. stearic acid, to obtain a better dispersion thereof in the polymer.

[0020]In this embodiment, the styrenic thermoplastic elastomer is preferably KRATON® (sold by KRATON POLYMERS RESEARCH S.A. - Avenue Jean Monnet 1- B-1348 Ottignies-Louvain-la-

Neuve) or SEPTON® (sold by KURARAY Co.,LTD.- Kuraray Nihonbashi BLDG.,3-1-6, Nihonbashi, CHUO-KU, TOKYO, 103-8254).

[0021]The amount of styrenic thermoplastic elastomer may be 10% to 40% by weight of the mixture. More preferably, the amount of styrenic thermoplastic elastomer may be 20% to 30 % by weight of the mixture. In any case, the amount of styrenic thermoplastic elastomer will be such as to obtain a hysteresis loss value, in the elastic hysteresis diagram, of 30% to 70% (preferably below 40%), between the 1st and the 2nd cycles detected at 50% elongation, and a residual deformation, after two cycles, below 30% (preferably below 10%). These parameters were obtained from tests that were carried out in standard environment conditions, by using an INSTRON dynamometer, series 5564, with a 3 inch sample, with 100 mm spaced terminals and with an elongation rate of 500 mm/minute.

[0022]The amount of polyolefin may vary depending on required elasticity and breathability. Preferably, the amount of polyolefin is 10 % to 50 % by weight of the mixture. More preferably, the amount of polyolefin is 25 % to 38 % by weight of the mixture. Yet more preferably, the amount of polyolefin is 27 % to 34 % by weight of the mixture.

[0023] Regarding the above ranges of weight percentages of the three components of the mixture (polyolefin, styrenic thermoplastic elastomer and filler), it shall be understood that any weight variation of a component implies an equal and offsetting weight variation of at least another component, so that the sum of weight percentages is always 100%.

Example

[0024]An admixture of 27% polyolefin, 27% styrenic thermoplastic elastomer and 46% fillers is blow extruded by means of a round head extruder 1, thereby obtaining a tube 10.

[0024]The temperature of the tube 10 that exits the extruder 1 is 150 to 230°C and preferably 170 to 190°C.

[0026]The blowing ratio of the tube 10 may be 1:2 to 1:4 and is preferably1:3.

[0027]The blow extrusion molded tube 10 is then calendered.

[0028]The tube 10 is fed, at a temperature of about 80 to 120°C, and more preferably of about 100°C, into a first calender 2, in which it is pressed and extended until it assumes a web shape 11, formed by two superimposed layers, whose width is half the circumference of the tube and whose thickness is twice the thickness of the tube.

[0029]The provision of two superimposed layers reduces the risk that, during the subsequent stretching step, the film may be damaged, i.e. that it may have areas with imperfect liquid imperviousness. In fact, tearing of the film at the same position on both layers is extremely rare.

[0030]The calender 2 which is used to stretch-thin the tube 10 has a pair of mated smooth rollers, the former being made of chromium plated steel and the latter being made of rubber with a hardness of 60 to 80 shores. The pressure exerted by the calender 2 on the compressed tube 10 is of 5 to 10 kg/cm^2.

[0031]After being flattened, the film 11 is heated to its softening point. This temperature depends on the type of extruded mixture, and may be 80 to 130°C, more preferably about 100°C.

[0032]Such heating assists removal of moisture and low-evaporation point additives from the extrusion mixture.

[0033]Furthermore, such heating assists the removal of microstrains in the film, which are formed during the previous steps of the process, and provides for a more uniform internal film structure. Thus, subsequent stretching is uniform throughout the film.

[0034]Heating is effected by first feeding the film 11 between heated rollers 3, having a temperature of about 60 to 100°C, and then passing the film 11 near infrared lamps 4 which further increases temperature to the softening point. In fact, by only using hot rollers – normally heated by water or oil – the softening point can hardly be reached, if at all. Furthermore, IR lamps provide the advantage of heating the air layer around the film (typically to 300 to 400°C), thereby allowing complete removal of residual moisture from the film 11.

[0035]After heating, the film is pressed once again by a second calender 5 and cooled to a temperature of 8 to 30°C. Such cooling is preferably by contact with one of the rollers of the calender 5, which is kept at a constant temperature of 8 to 30°C.

[0036]Due to roller compression, this additional calendering step strongly joins the two original layers, and prevents any delamination of the film, while the thermal shock produced in the film stops the stabilization process. In this step, the film may be optionally embossed for aesthetic purposes, without altering its basic weight.

[0037]The thermal shock produced in the film was found to improve the breathability imparted during the following stretching step.

[0038]Film compression is obtained by combining a chromium-plated steel roller and a rubber roller (having a hardness of 60 to 80 shores).

[0039]After the stabilization step, the film 11 is stretched in the transverse and/or longitudinal direction. To this end, appropriate stretching means 6, 8 are provided for stretching the film in the transverse and/or longitudinal direction of the film. Obviously, these stretching steps may be reversed. Preferably, extending rollers 7 are provided between the transverse stretching means 6 and the longitudinal stretching means 8, to remove the folds generated by the first stretching process. Typical longitudinal stretching ratios range from 1:1.5 to 1:4, with the most preferred ratio being1:3.5. Similarly, transverse longitudinal stretching ratios range from 1:1.5 to 1:2.5. Nevertheless, if required, stretching may even reach a ratio of 1:4. Within such ranges, vapor permeability levels of 500 to 10000 (g/m^2) 24h, as detected by using a Mocon – Permatran W instrument, model 100K, with the INDA IST 70.4 method (99), may be obtained.

[0040]After being transversely and/or longitudinally stretched, the film 11 passes through a stretch stabilizing station to minimize film snapback.

[0041]Hence, by a succession of operations performed on the surface of the stretched film, any undesired shrinking or wrinkling effect is prevented.

[0042]Cold stabilization may be carried out by passing the film between two rollers which are maintained at a temperature of 8° to 30°C.

[0043]Once the film has been stretched, it can undergo any known surface processing.

[0044]After surface processing, if any, the film 11 may be conveyed to a consumer system or wound by a reeling machine 9 for storage.

[0045]The extruded film has a high surface adhesiveness, which would actually prevent the roll from being unwound without damaging the film. Therefore, before winding the film into a roll, a separating material is applied on the extruded film 11, to prevent any direct contact between contiguous turns of the roll. To this end, a special station 12 is provided for covering the stretched elastic film 11 with the separation material. Thus, the turns of the roll 18 may be successively unwound without incurring any problem associated with the adhesion of the film to itself.

[0046]The separating layer may have a continuous structure. Typically, this layer is a film made of paper or nonwoven fabric which may be coupled to the film with or without interposing an adhesive therebetween, depending on the end use of the film. The adhesive may be delivered by means of a special device 14.

[0047]Alternatively, the separation material may have a discontinuous structure. In this case, it may be a powdery material applied to the surface of the extruded film. Suitable powdered materials include, for instance, talc, plaster and marble.